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CITY OF BRAMPTON TRANSPORTATION MASTER PLAN UPDATE

TECHNICAL REPORT #1 - MODEL VALIDATION

NOVEMBER 2013

MMM GROUP

Document Control:

Client:	City of Brampton
Project Name:	City of Brampton Transportation Master Plan Update
Report Title:	Brampton Model Validation
MMM Reference:	1613074-001-T01
Version:	1
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Circulation List:	

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1.0 Introduction

This report documents the performance of the City of Brampton's Simplified GTA Model, and existing baseline conditions for the 2011 horizon year. The model is hereafter referred to as BSGM, and its performance is measured using the 2011 TTS and 2011 Cordon Count Data, wherever possible. This report is a "living document", which will be updated as additional input and validation data is made available, and further refinements are completed in Stage 2 of the model update.

Through the course of the model review exercise, the team has made updates to the BSGM in order to improve its performance and forecasting abilities. These improvements have spanned both the demand (four-stages) and supply (auto and transit network) side of the BSGM.

The report is divided into two primary sections. First, supply review, which addresses the accuracy of the 2011 road and transit networks to reflect existing (2011) conditions. Second, demand review, which encompasses the trip generation, trip distribution, mode split, and the road and transit assignment stages of the BSGM. The sequence in which the four-stages of the model are presented has been altered to maintain a logical flow for discussion purposes, and does not reflect the actual internal workings of the BSGM.

Issues

Stage 1 Update

Stage 2 Update

Throughout the report we have identified issues (blue badge) with the model and the corresponding timelines to address them. Updates which were deemed critical to the development of the Development Charge study have been identified as Stage 1 (orange badge) and the results presented in this document reflect those updates. Updates that would predominantly benefit the Transportation Master Plan process are identified as Stage 2 (green badge), and planned for February 2014.

2.0 Supply Review

2.1 Road Network

A review of the 2011 road network within the City of Brampton and its immediate vicinity was completed. The network was compared to information provided by the City of Brampton staff as well as to satellite images of the areas under question. The review addressed the following network characteristics:

Stage 1 Update

- Number of lanes;
- Link speeds;
- Volume-delay-functions;
- Per lane link capacity; and,
- Length and number of Centroid Connectors within Traffic Analysis Zones (TAZs) in key corridors.

A detailed listing of the changes is presented in **Appendix A**.

2.2 Transit Network

A comprehensive review of the transit networks in the City of Brampton and City of Mississauga was also completed, checking for consistency across the following characteristics:

Stage 1 Update

- Line itineraries;
- Headways;
- Speeds;
- Bus stops; and,
- Walk connectors to transit lines.

A detailed listing of the changes is presented in **Appendix B**. Of note, the review of the transit networks was not limited to local transit services, but also intra-regional services such as GO Transit that are operating within the City of Brampton.

3.0 DEMAND REVIEW

3.1 Super Zones

A two-tier system of super zones was created to assist in the validation of the model. The first tier divided the entire GTHA into a series of nine internal and one external super zone, as shown in **Figure 1**. The second tier divides the City of Brampton into six super zones, as shown in **Figure 2**.

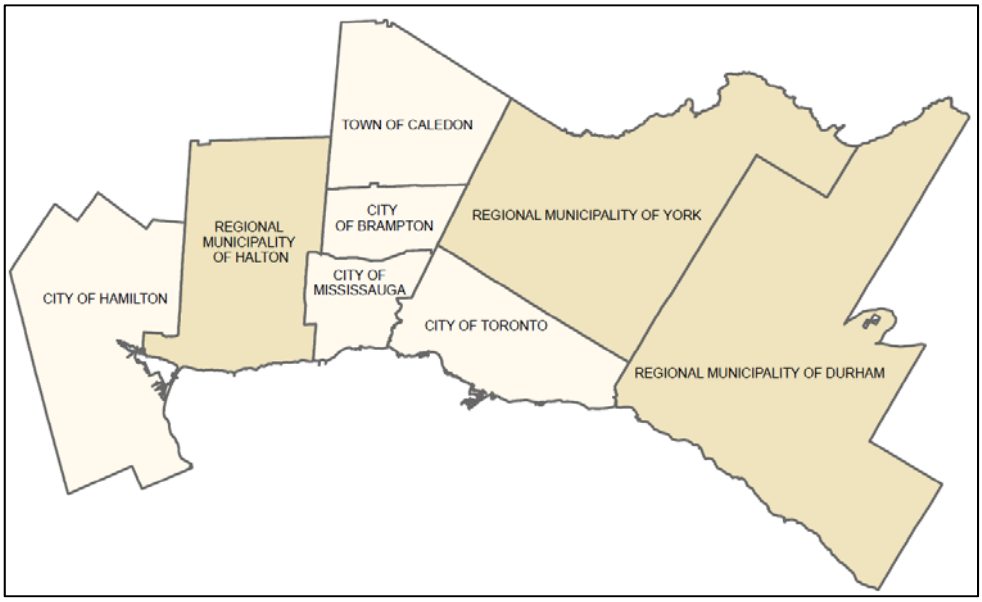


Figure 1: Tier 1 Super Zone System

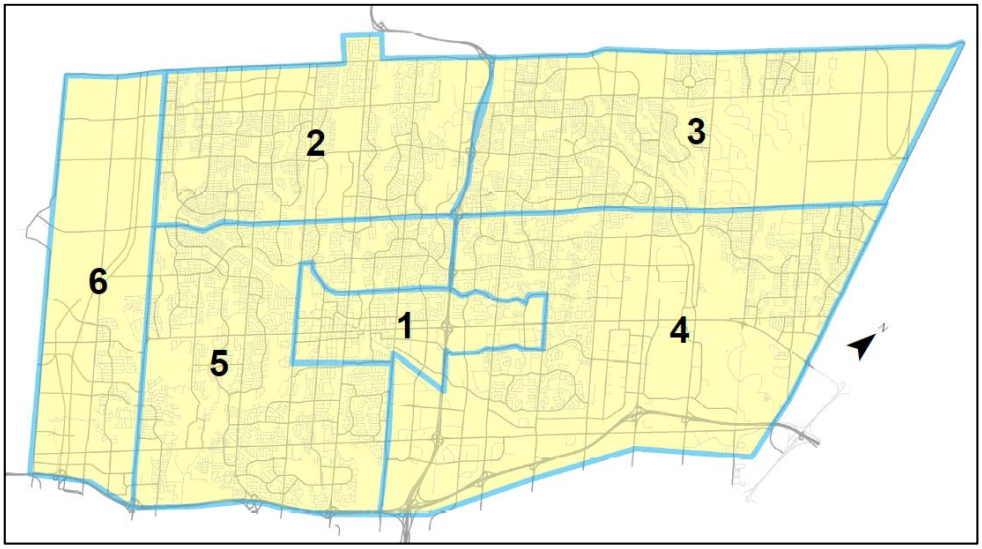


Figure 2: Tier 2 Super Zone System - City of Brampton

3.2 Population/Employment Distribution

Figure 3 shows the 2011 census-based distribution of population and employment in the City of Brampton. The area south of Queen Street and east of Main Street is predominantly employment based, including sections along Torbram Road and Airport Road. The rest of the city is primarily residential with some employment lands.
The 2011 population and employment for the City of Brampton are as follows:

- Population: 510,002
- Employment: 181,930

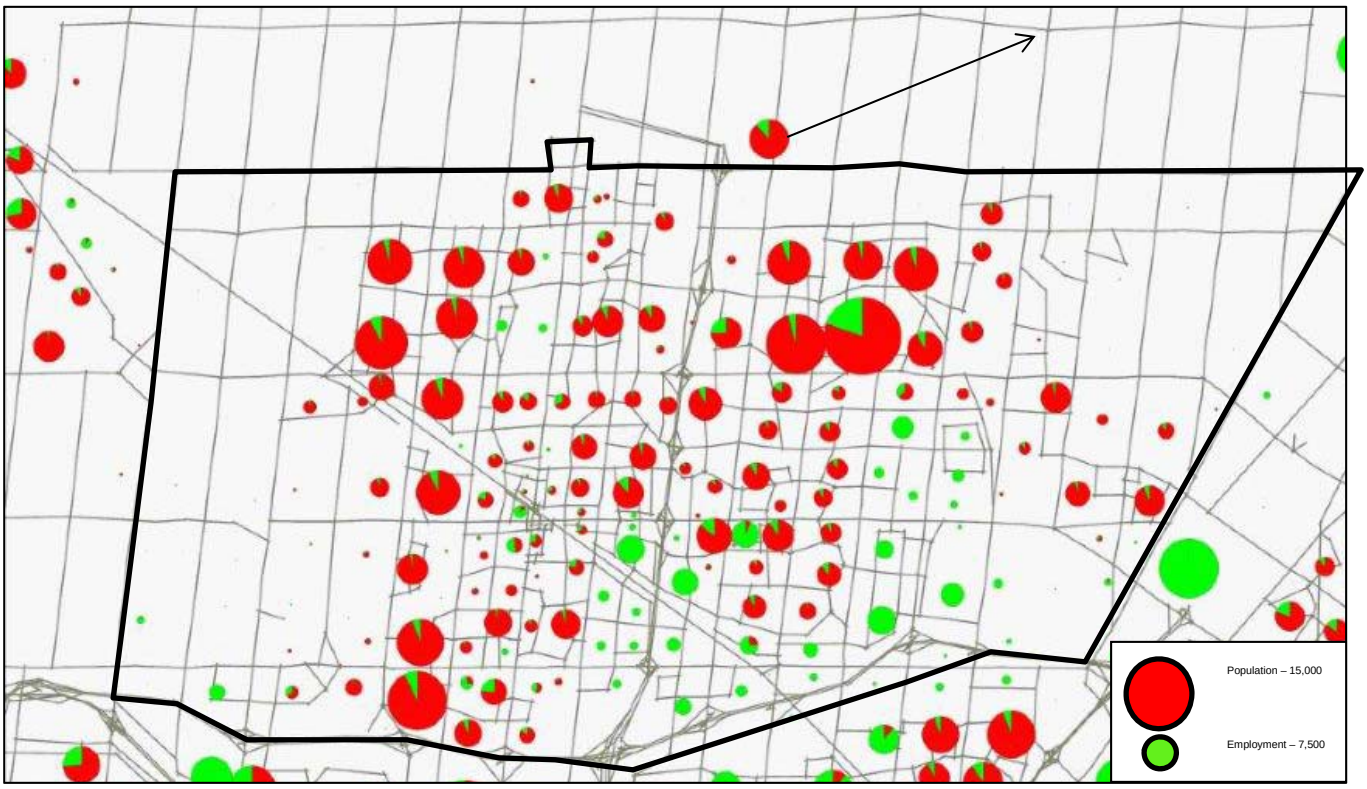


Figure 3: City of Brampton - 2011 Census Distribution of Population and Employment

Mode	Productions		Attractions	
	2011 TTS	2011 Model	2011 TTS	2011 Model
All Modes*	197,401	212,233	234,151	254,936

Table 1: P.M. Peak Period Trip Generation - City of Brampton
** all modes represent auto driver, auto passenger, GO rail, local transit only*

Issue: Overreporting of trips

Stage 2 Update

Given the preliminary nature of the 2011 TTS data and the marginal under reporting to be expected in the TTS (3%-5%), this discrepancy in the total trips is not a cause of concern for Stage 1 of the update. However, this discrepancy can inflate trips by non-auto modes of transportation, such as local transit and GO Rail, warranting an investigation for Stage 2 of the model update.

3.3.2 Special Generator Trips

Special generators in the model represent traffic analysis zones (TAZs) that have very different trip making characteristics from the surrounding TAZs, thereby having the potential to make a major impact on the transportation system. An important consideration for identifying special generators is that they be represented by a single TAZ with no other land uses within it so that their impact can be isolated and quantified.

Issue: Special Generators

Stage 2 Update

In general, special generators are represented by large shopping malls, educational institutions, hospitals, military bases etc. Within the City of Brampton there are a number of such potential special generators, as shown in **Appendix C**. However, only a few could be studied because most of the special generators were integrated with other land uses. For example, The Brampton Civic Hospital at the intersection of Bovaird Drive and Bramalea Road by definition is a special generator, but the TAZ that it lies in (TAZ # 1719) includes residential sub-divisions to the north and east. A similar situation was encountered for the Bramalea Civic Centre and Shoppers World.

The Sheridan College campus located at the intersection of McLaughlin Road and Steeles Avenue West is represented by a single TAZ (TAZ # 1905) in the model, which allowed the comparison of the model trips to those estimated by the ITE Trip Generation Manual 7.0, as shown in **Table 2**. The results show that the BGSM's trip estimates for Sheridan College are within 10% of those estimated by the ITE Manual.

Table 2: P.M. Peak Period Comparison - Special Generator

Generator Name	TAZ	Model		ITE Estimate		Model - ITE Estimate		Model / ITE Estimate	
		Prod	Attr	Prod	Attr	Prod	Attr	Prod	Attr
Sheridan College	1905	1,648	772	1,523	717	125	55	1.08	1.08

** The PM peak hour ITE trips were expanded to the PM peak period using a factor of 0.37*

3.4 Mode Split

The City of Brampton has recently implemented a new modal split sub-model as part of the BGSM. This new approach uses a look up table to assign mode split percentages based on transit level of service, stratified geographically between the City of Toronto and the rest of the GTHA. The macro requires two input files, which allow the user to control the percentage of modal split adjustment for each TAZ. First, a file that contains the municipal (Planning District) adjustment factors (*area.prn*), and second, a lookup table with transit modal split values based on the level of service criteria (*ms_input.prn*).

One of the significant discrepancies in the original BGSM revolved around the "Other Transit" mode. *The original 2011 model reported 9,239 transit trip productions and 11,422 transit trip attractions, for the 2011 P.M. peak period.* Both these P.M. peak period trips were not only significantly lower than the 2011 TTS estimates (Table 3), but also lower than the 2006 TTS estimates, which reported 9,307 transit trip productions and 13,012 transit trip attractions.

Stage 1 Update

During the course of the model review, it was decided to update the inputs in the *area.prn* file that contains the municipal (Planning District) adjustment factors to improve the BGSM's estimated transit trips. This approach allows the user to focus adjustments to the City of Brampton only, as opposed to the lookup table (*ms_input.prn*), which is applied based on a TAZs level of service rating and affects TAZs outside the City of Brampton as well.

Table 3 compares the 2011 P.M. peak period trips by mode after the above update, and the auto and transit updates listed in **Appendix A** and **B**.

Mode	Productions		Attractions	
	2011 TTS	2011 Model	2011 TTS	2011 Model
Auto Person	186,760 (94.6%)	201,435 (94.9%)	213,389 (91.1%)	231,647 (90.8%)
GO Rail	96 (0.1%)	46 (0%)	3,921 (1.6%)	5,677 (2.3%)
Other Transit	10,545 (5.3%)	10,752 (5.1%)	16,841 (7.1%)	17,612 (6.9%)
All Modes*	**197,401 (100%)**	**212,233 (100%)**	**234,151 (100%)**	**254,936 (100%)**

Table 3: 2011 Updated Model P.M. Peak Period Trips by Mode

** all modes represent auto driver, auto passenger, GO rail, local transit only*

The mode shares estimated by the BSGM are relatively close to observed 2011 TTS values. However, the GO Rail mode exhibits close to 45% more trip attractions and consequently higher mode shares than observed.

Issue: GO Rail Trips

This GO Rail discrepancy between the 2011 TTS and the model can be attributed partly to the over reporting of total trips (Table 1) by the BSGM. There is a possibility to dampen the "GO Rail destinations" input file and bring the trips in-line with observed values, but this refinement is best suited for Stage 2 of the model update.

Stage 2 Update

Figure 4 shows P.M. peak period boardings by mode for transit lines operated by the City of Brampton. As expected, close to 84% (15,686 peak period boardings) of the P.M. peak period boardings take place on the local transit system, with the express Zum service accounting for the remaining 16%. Of note, this does not represent boardings that take place on transit systems operated by other municipalities, such as Mississauga Transit, GO Transit etc., within the City boundary. Given the relatively short time that the Zum service was operational prior to 2011, it represents a substantial share of the total boardings and is expected to continue to rise as the service is refined and expanded.

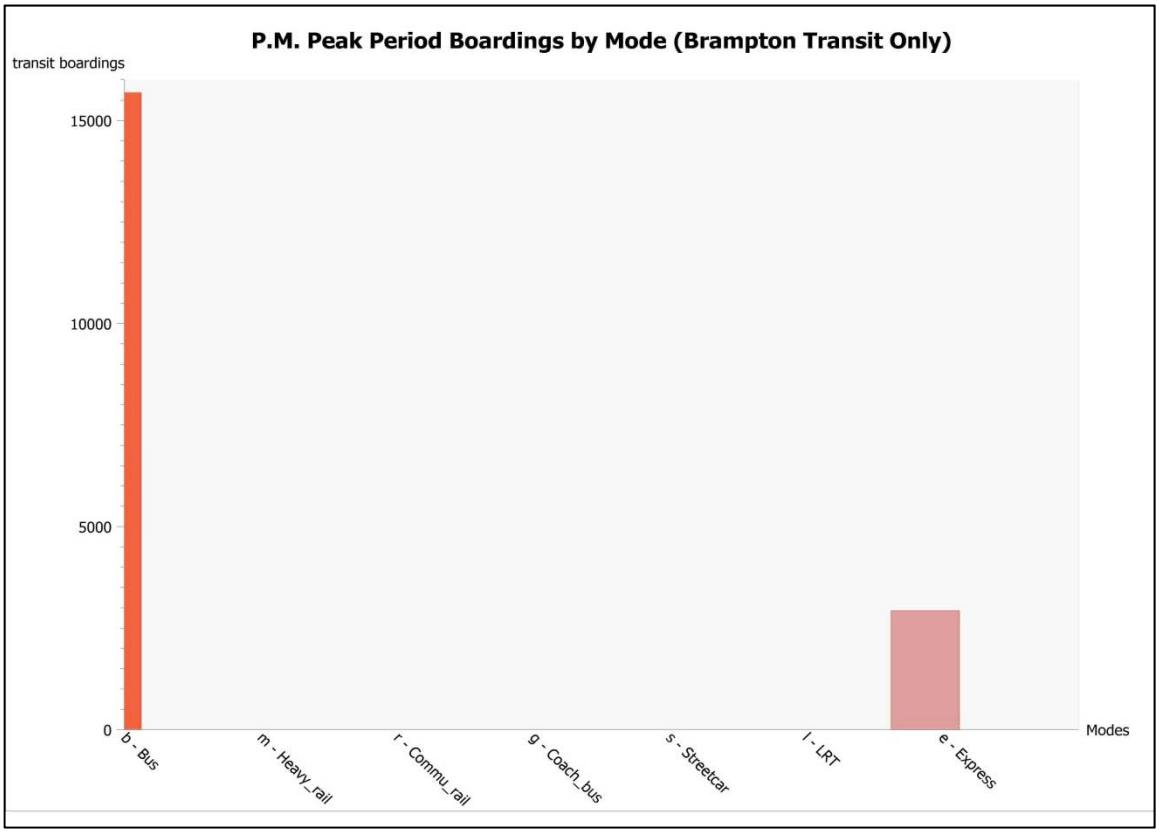


Figure 4: P.M. Peak Period Boardings by Mode (Brampton Transit Only)

3.5 Trip Distribution

The trip distribution from the 2011 model was compared to the 2011 P.M. peak period TTS data, as shown in **Table 4** and **Table 5.** Trips internal to the City account for close to 69% of the entire P.M. peak period trip making, followed by the City of Mississauga, and the City of Toronto.

Table 4: TTS vs. Updated Model - 2011 P.M. Peak Period Trips for all Modes*

Planning Districts		City of Toronto	Durham Region	York Region	Town of Caledon	City of Brampton	City of Mississauga	Halton Region	Hamilton Region	External Area	% of Brampton Total Attraction	Total Production
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9		
City of Toronto	2011 TTS					32,794					14%	
Durham Region						511					0%	
York Region						9,148					4%	
Town of Caledon						3,825					2%	
City of Brampton		12,605	736	7,058	5,010	136,756	20,989	7,674	1,166	5,407	58%	**197,401**
City of Mississauga						42,899					18%	
Halton Region						5,083					2%	
Hamilton Region						831					0%	
External Area						2,304					1%	
% of Brampton Total Production		6%	0%	4%	3%	69%	11%	4%	1%	3%	100%	
Total Attraction						**234,151**						**3,573,445**

Planning Districts		City of Toronto	Durham Region	York Region	Town of Caledon	City of Brampton	City of Mississauga	Halton Region	Hamilton Region	External Area	% of Brampton Total Attraction	Total Production
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9		
City of Toronto	2011 Model					34,408					13%	
Durham Region						815					0%	
York Region						11,424					4%	
Town of Caledon						5,385					2%	
City of Brampton		12,849	843	7,320	7,587	146,732	20,343	7,835	1,219	7,505	58%	**212,233**
City of Mississauga						45,742					18%	
Halton Region						6,311					2%	
Hamilton Region						787					0%	
External Area						3,332					1%	
% of Brampton Total Production		6%	0%	3%	4%	69%	10%	4%	1%	4%	100%	
Total Attraction						**254,936**						**3,694,687**

** all modes represent auto driver, auto passenger, GO rail, local transit only*

Transit (non-GO Rail) is a key mode of transportation for trips to, from, and internal to the City due to the significant increase in congestion, introduction of the Zum express service, and the projected future population and employment growth in the City. In light of the above, Table 4 compares the 2011 modeled P.M. peak period transit (non-GO Rail) distribution to the observed 2011 TTS distribution.

Table 5: TTS vs. Updated Model - 2011 P.M. Peak Period Trips for Local Transit Only

Planning Districts		City of Toronto	Durham Region	York Region	Town of Caledon	City of Brampton	City of Mississauga	Halton Region	Hamilton Region	External Area	% of Brampton Total Attraction	Total Production
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9		
City of Toronto	2011 TTS					4,633					28%	
Durham Region						-					0%	
York Region						413					2%	
Town of Caledon						143					1%	
City of Brampton		876	-	122	51	8,244	1,189	18	-	45	49%	**10,545**
City of Mississauga						3,000					18%	
Halton Region						126					1%	
Hamilton Region						84					0%	
External Area						198					1%	
% of Brampton Total Production		8%	0%	1%	0%	78%	11%	0%	0%	0%	100%	
Total Attraction						**16,841**						**509,511**

Planning Districts		City of Toronto	Durham Region	York Region	Town of Caledon	City of Brampton	City of Mississauga	Halton Region	Hamilton Region	External Area	% of Brampton Total Attraction	Total Production
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9		
City of Toronto	2011 Model					4,756					27%	
Durham Region						-					0%	
York Region						689					4%	
Town of Caledon						-					0%	
City of Brampton		859	-	137	-	8,581	1,119	56	-	-	49%	**10,752**
City of Mississauga						3,503					20%	
Halton Region						53					0%	
Hamilton Region						30					0%	
External Area						-					0%	-
% of Brampton Total Production		8%	0%	1%	0%	80%	10%	1%	0%	0%	100%	
Total Attraction						**17,612**				-		**511,926**

As shown in **Table 4**, the revised municipal adjustment factors (documented in Section 2.4) result in a very accurate fit of 2011 modeled transit trip distributions to the 2011 TTS data. The modeled 2011 transit trip attractions to the City of Brampton are marginally over reported (5%). This is not a significant discrepancy that would warrant any further adjustment to the transit parameters during Stage 1 of the model update.

A similar comparison of transit trips was also completed using the second tier super zones, as shown in **Table 6**.

Table 6: TTS vs. Updated Model - 2011 P.M. Peak Period Transit Trips (City of Brampton Only)

	Super Zone	1	2	3	4	5	6	Total
2011 TTS	1	598	204	156	245	454	-	1,657
	2	137	200	-	73	247	-	657
	3	286	85	304	192	23	-	890
	4	700	299	480	762	773	24	3,038
	5	531	310	78	156	854	-	1,929
	6	27	-	-	-	23	-	50
	Total	2,279	1,098	1,018	1,428	2,374	24	8,221

	Super Zone	1	2	3	4	5	6	Total	Mod/Obs
2011 Model	1	151	317	366	318	661	2	1,815	1.10
	2	75	172	225	161	240	1	874	1.33
	3	87	84	184	147	78	-	580	0.65
	4	236	665	971	915	840	2	3,629	1.19
	5	156	293	165	189	822	5	1,630	0.84
	6	2	10	6	6	29	-	53	1.06
	Total	707	1,541	1,917	1,736	2,670	10	8,581	1.04
	Mod/Obs	0.31	1.40	1.88	1.22	1.12	0.42	1.04	1.04

Issue: Transit trip imbalance

Although the total modeled transit trips (internal to Brampton) are within 4% of the 2011 observed transit trips, there are substantial variations between the super zones. The most significant discrepancy exists in trip attractions to super zone 1 (Downtown Brampton), which is under represented by close to 70%, and subsequently, super zone 2 and 3 which exhibit significantly higher trip attractions. The model does not contain any explicit input file or "lever" that can be used to correct this imbalance, thus a number of different methodologies can be implemented to address this issue.

Stage 2 Update

For example, introducing more refinement to the super zone geography (such as the tier 2 super zone system) within the City, will allow the implementation of different municipal adjustment factors. In addition, new categories in the transit mode split lookup table (*ms_input.prn*) can be created to capture the uniqueness of Downtown Brampton. The final methodology will be arrived upon after a detailed assessment and is best suited for Stage 2 of the model update.

3.6 Assignment

3.6.1 Auto Assignment

The model's auto performance was tested against a number of screenlines across the City. The screenlines are shown in **Figure 5**.

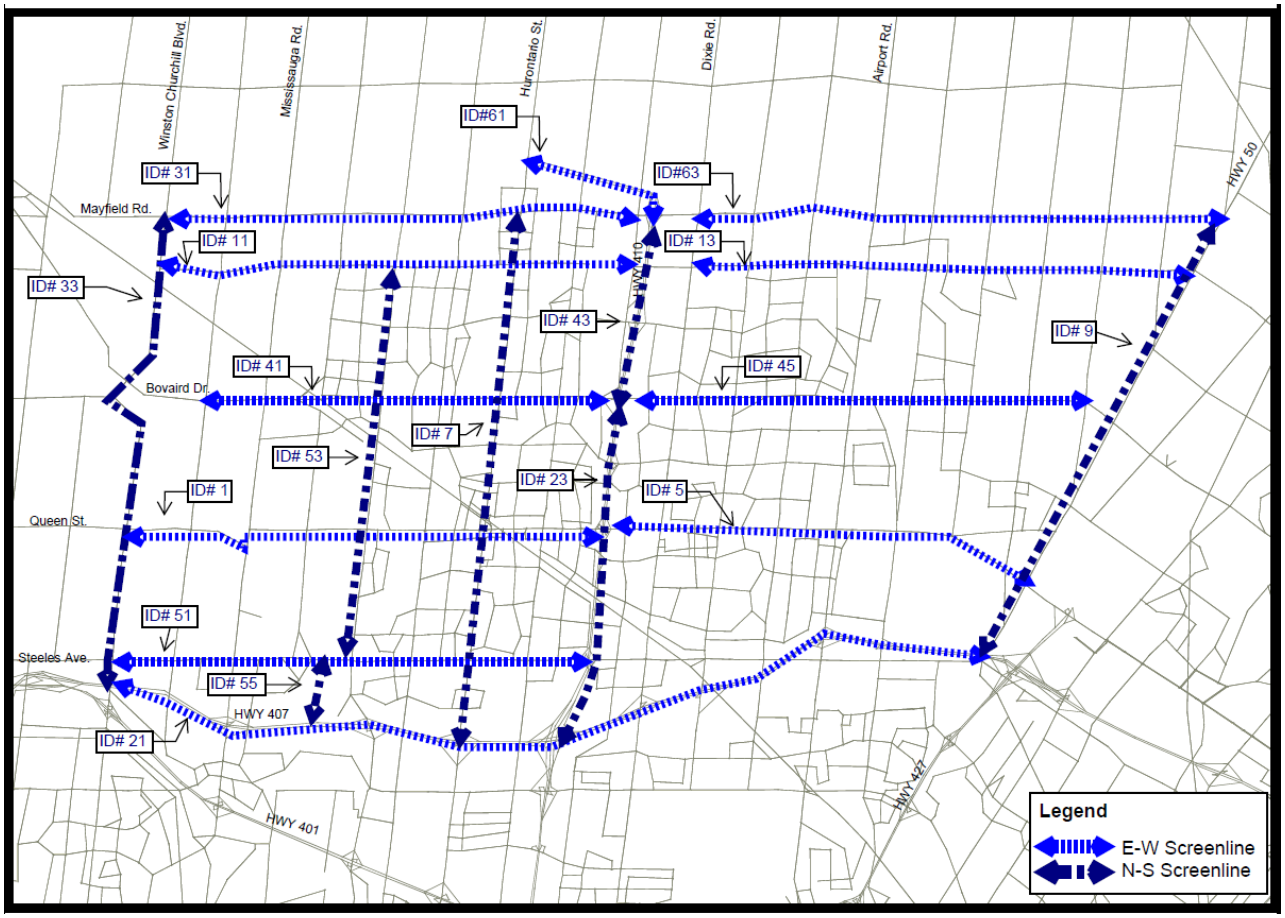


Figure 5: Screenline Definitions

Table 7 and **Table 8** compare the model's auto assignment against observed counts for the P.M. peak hour.

Table 7: P.M. Peak Hour and Peak Direction Comparison of Observed vs. Updated Model Auto Assignment

Screenline	ID #	Target (Obs.) Auto Volume	Model Capacity	Modelled Volume	Model-Obs	Ratio Model/Obs	GEH*
PM Peak Hour							
52A - Caledon boundary - W. Churchill to Heart Lake Northbound	31	2,164	9,150	2,184	20	1.01	0.4
52B - Hwy 410 South of Mayfield Northbound	61	1,697	3,600	2,230	533	1.31	12.0
52C - Caledon boundary - Dixie to Hwy 50 Northbound	63	3,457	9,200	4,663	1,206	1.35	18.9
South of Wanlass/Conservation Drive - W. Churchill to Heart Lake Northbound	11	3,456	9,450	2,423	-1,033	0.70	19.0
South of Countryside - Dixie to Hwy 50 Northbound	13	2,459	6,600	2,240	-219	0.91	4.5
84A - South of Bovaird - Heritage to South Lake Northbound	41	5,561	10,050	5,323	-238	0.96	3.2
84B - Hwy 410 South of Bovaird - Northbound	43	4,574	5,400	4,601	27	1.01	0.4
84C- South of Bovaird/Castlemore - Nasmith to Clarkway Northbound	45	5,897	13,800	7,275	1,378	1.23	17.0
South of Queen - W. Churchill to Rutherford Northbound	1	6,320	8,950	6,515	195	1.03	2.4
South of Queen - West Rd to Hwy 50 Northbound	5	4,705	7,300	4,581	-124	0.97	1.8
South of Steeles - W. Churchill to Hwy 410 Northbound	51	5,527	8,550	5,415	-112	0.98	1.5
42- Brampton/Mississauga Northbound	21	26,259	32,300	23,866	-2,393	0.91	15.1
31A- Brampton/Halton Westbound	33	7,093	11,850	8,065	972	1.14	11.2
West of Chinguacousy/Mavis Westbound	53	1,502	4,800	1,541	39	1.03	1.0
Highway 407 & Steeles Av at the Credit River Westbound	55	5,681	9,000	6,976	1,295	1.23	16.3
72A - E. of Hurontario Westbound	7	15,775	21,100	16,313	538	1.03	4.2
73- East of Hwy 410 Westbound	23	19,321	27,800	20,462	1,141	1.06	8.1
33B - Brampton/York Westbound	9	13,156	17,800	13,240	84	1.01	0.7
Total		**134,604**	**216,700**	**137,913**	**3,309**	**1.02**	**9.0**

* *The GEH statistic is used to measure the amount of error in the simulated results versus the actual observed volumes.*

***Good** – GEH<5; **Acceptable** – 5<GEH<10; **Not Acceptable** – GEH>10*

Table 8: P.M. Peak Hour and Off-Peak Direction Comparison of Observed vs. Updated Model Auto Assignment

Screenline	ID #	Target Auto Volume	Model Capacity	Modelled Solume	Model-Obs	Ratio Model/Obs	GEH
PM Peak Hour							
52A - Caledon boundary - W. Churchill to Heart Lake Southbound	32	1,817	7,350	1,513	-304	0.83	7.5
52B - Hwy 410 South of Mayfield Southbound	62	974	3,600	981	7	1.01	0.2
52C - Caledon boundary - Dixie to Hwy 50 Southbound	64	2,185	9,200	2,766	581	1.27	11.7
South of Wanlass/Conservation Drive - W. Churchill to Heart Lake Southbound	12	2,995	9,450	1,853	-1,142	0.62	23.2
South of Countryside - Dixie to Hwy 50 Southbound	14	1,609	6,600	1,127	-482	0.70	13.0
84A - South of Bovaird - Heritage to South Lake Southbound	42	3,814	10,050	3,590	-224	0.94	3.7
84B - Hwy 410 South of Bovaird - Southbound	44	2,293	5,400	3,228	935	1.41	17.8
84C- South of Bovaird/Castlemore - Nasmith to Clarkway Southbound	46	4,601	13,800	4,289	-312	0.93	4.7
South of Queen - W. Churchill to Rutherford Southbound	2	4,048	8,950	3,938	-110	0.97	1.7
South of Queen - West Rd to Hwy 50 Southbound	6	2,771	7,300	2,522	-249	0.91	4.8
South of Steeles - W. Churchill to Hwy 410 Southbound	52	4,014	8,550	3,762	-252	0.94	4.0
42- Brampton/Mississauga Southbound	22	16,322	32,300	15,160	-1,162	0.93	9.3
31A- Brampton/Halton Eastbound	34	4,110	11,850	5,243	1,133	1.28	16.6
West of Chinguacousy/Mavis Eastbound	54	1,195	4,800	1,188	-7	0.99	0.2
Highway 407 & Steeles Av at the Credit River Eastbound	56	4,667	9,000	5,662	995	1.21	13.8
72A - E. of Hurontario Eastbound	8	13,065	20,600	11,722	-1,343	0.90	12.1
73- East of Hwy 410 Eastbound	24	13,179	26,400	14,346	1,167	1.09	9.9
33B - Brampton/York Eastbound	10	9,474	17,800	10,361	887	1.09	8.9
SUM		**93,132**	**213,000**	**93,251**	**119**	**1.00**	**0.4**

***Good** – GEH<5; **Acceptable** – 5<GEH<10; **Not Acceptable** – GEH>10*

Given the strategic nature of the BSGM and the significant variation that can be expected at individual screenlines due to localized congestion and routing choices, the model performs reasonably well. *Of note, the original (prior to the updates listed in this report) 2011 model under reported 2,800 vehicles in the peak direction, and over reported 460 vehicles in the off-peak direction.*

Table 6 and **7** show that there exist substantial discrepancies at some individual screenlines (GEH>10). However, none of those screenlines are operating close to capacity, which suggests that the model's performance is not distorting the current capacity constraints in the system.

Figure 6 shows the 2011 observed and modeled volume-to-capacity ratios (v/c) across the screenlines, for the peak direction.

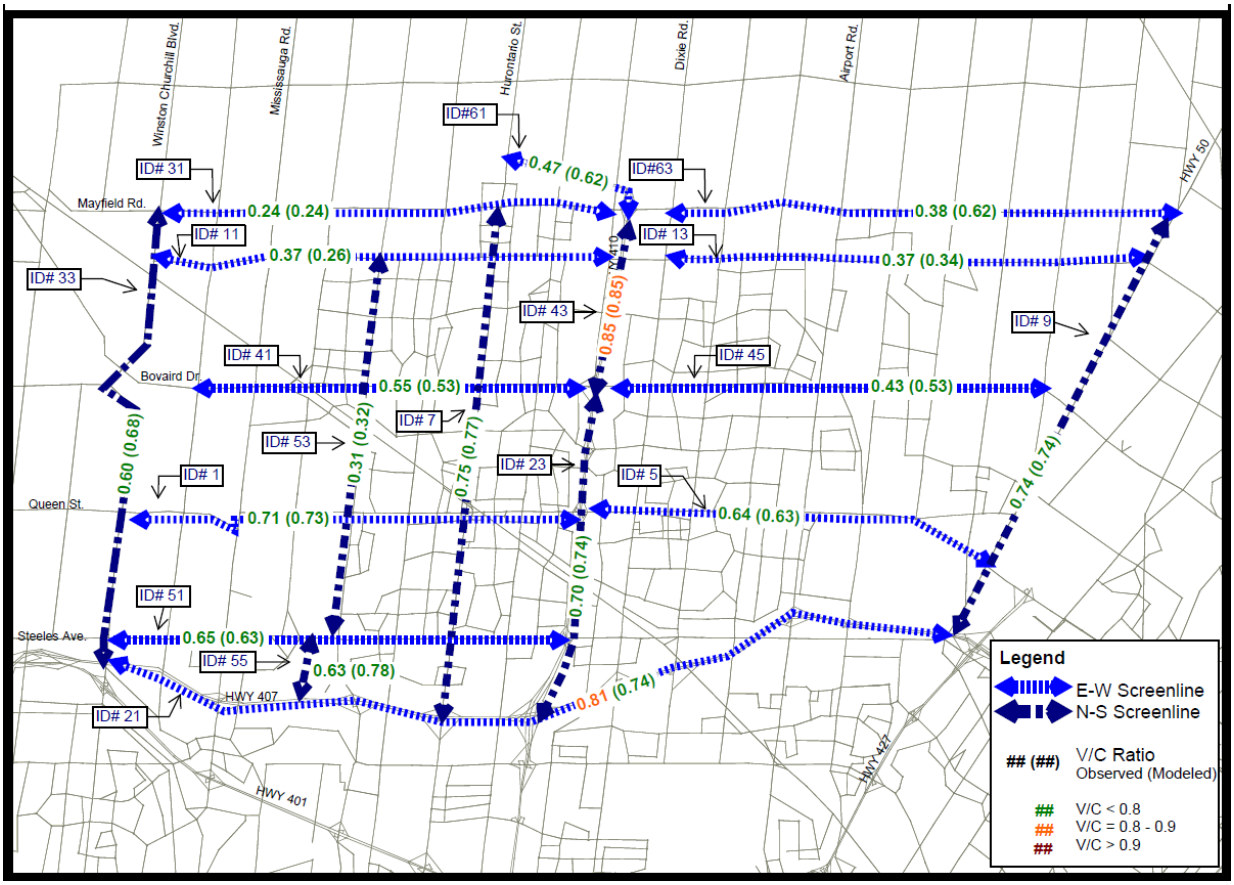


Figure 6: 2011 Updated Model and Observed Screenline VC Ratios - Peak Direction

In the peak direction, only Screenline # 43 and Screenline # 21 have an *observed* v/c ratio of greater than 0.8 in; and, only screenline #43 exhibits a *modeled* v/c ratio of greater than 0.8. The analysis suggests that there is enough surplus capacity in the system to handle the P.M. peak hour demands. Of note, the screenlines used in the model traverse a wide area with substantially varying land uses. This tends to smooth out capacity deficiencies in the system. A problem compounded by the fact that strategic link level models do not capture local traffic operation issues well.

Thus, temporary congestion along key corridors such as Queen Street is not accurately represented through the screenline analysis. In the off-peak direction all the screenlines exhibit a v/c ratio of lesser than 0.8. **Table 9** documents some key system metrics of the 2011 road network. These metrics will be also be used for benchmarking future network performance.

Table 9: 2011 Updated Model System Metrics

System Metrics	Year: 2011
Daily Vehicle Kilometers Traveled (VKT)*	10,819,960
Daily Vehicle Hours Travelled (VHT)*	199,198
Total Lane Kms	3,565
% VKT on v/c>0.8	3,084,929
% VHT on v/c>0.8	59,357
% Congested Lane Kms (v/c>0.8)	271
GHG Emissions	1141 kt**

**peak hour to daily conversion done using a multiplier of 10*
***GHG emissions estimated for auto mode only*

3.6.2 Highway 407 Performance

Highway 407 runs along the southern boundary of the City of Brampton and plays a significant role in moving traffic to, from, and through the City. Given its importance and unique nature (toll road), a comparison of the 2011 modeled P.M. peak hour volumes and observed traffic was completed and is presented below in **Table 10**.

Table 10: Comparison of Highway 407 P.M. Peak Hour Assignment - Updated Model to Observed Counts

Station Location	2011 Cordon Count		2011 Modeled		GEH	
	EB	WB	EB	WB	EB	WB
Highway 407 at Peel/York Boundary	5,323	8,148	6,066	6,072	10	25
Highway 407 East of Highway 410	3,561	5,244	5,307	7,068	26	23
Highway 407 East of Highway 10	3,762	5,942	4,881	7,195	17	15
Highway 407 at Credit River	3,372	4,613	4,511	6,016	18	19
Highway 407 West of Winston Churchill Blvd	1,912	3,994	3,609	5,238	32	18
Total	**17,930**	**27,941**	**24,374**	**31,589**	**44**	**21**

***Good** – GEH<5; **Acceptable** – 5<GEH<10; **Not Acceptable** – GEH>10*

Results presented in Table 9 show that the model significantly over estimates 2011 P.M. peak hour volumes along Highway 407. This problem is not specific to the BSGM only; it is systemic to all the models built in the GTHA. The issues surrounding this over estimation are both fundamental (such as value-of-time estimates, different users have different value-of-times etc.) and operational (ramp penalties etc.).

Further, travel behavior generally suggests that users on average will not use a toll highway to make short distance trips given the explicit out-of-pocket costs associated with the trip. Using this as a basis, the trip length frequency distribution along Highway 407 was computed for the updated 2011 model, and is shown in **Figure 7**.

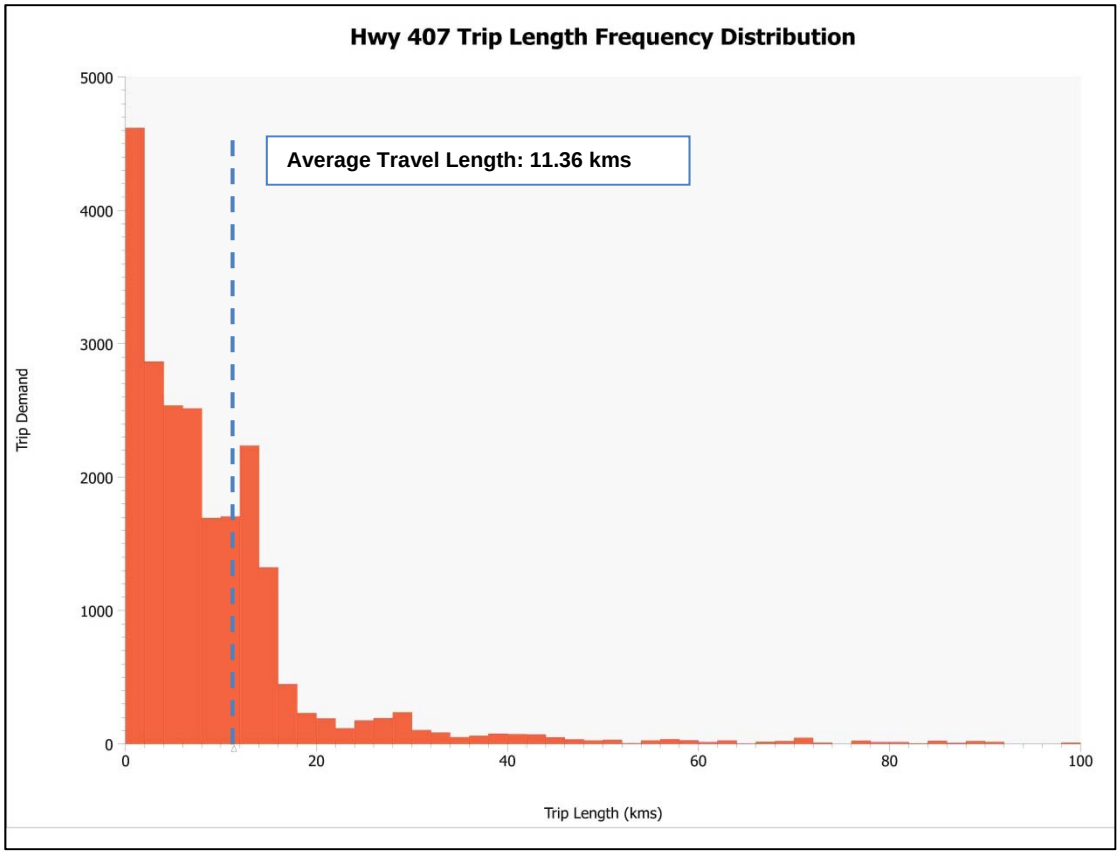


Figure 7: 2011 Updated Trip Length Frequency Distribution - Highway 407

Issue: Hwy 407 over estimation

Stage 2 Update

The updated 2011 model estimates an average trip length of 11.36 kms for trips along Highway 407, as compared to an average of 19.48 kms reported by the Ministry of Transportation (MTO) at the 17th International EMME Users Conference (2003). The increase in congestion on the network between the 2003 Study and 2011 would have subsequently resulted in a rise in value-of-time relative to toll costs, thus making Highway 407 potentially more attractive to short distance trips; however, a nearly 41% increase in trip lengths is highly unlikely.

The significant over estimation of modeled volumes along Hwy 407 (Table 9) and the relatively short average trip lengths (Figure 6) suggests that the highway is being used by a number of short distance trips. We strongly recommend addressing this issue in Stage 2 of the model update, using a “step function” approach that we have recently implemented for the York Region model.

3.6.3 Travel Times in Key Corridors

Modeled travel times along key corridors in the City were compared to the 2010 Travel Time Survey conducted by MTO, and the results are presented in **Table 11.** The results reflect the updates that were carried out to the volume-delay-function definitions (shown in Appendix A), and the refinement of the auto and transit network.

Table 11: 2011 Updated Model Travel Time Comparisons

Roadway	Segment	Peak Direction (N/W)			Off-Peak Direction (S/E)		
		Travel Time Survey	2011 Model	Model / Survey	Travel Time Survey	2011 Model	Model / Survey
Airport Rd	Steeles Ave and Mayfield Rd	12.10	12.42	1.03	15.12	9.47	0.63
Bovaird Dr	Adamson St and Airport Rd	26.15	20.75	0.79	26.25	18.38	0.70
Bramalea Rd	Steeles Ave and Bovaird Dr	8.53	7.90	0.93	10.02	7.07	0.71
Castlemore Rd	Airport Rd and County Road 50	8.28	6.88	0.83	8.23	6.81	0.83
Chinguacousy Dr	Steeles Ave and Mayfield Rd	13.33	13.18	0.99	13.43	11.85	0.88
Dixie Rd	Hwy 407 and Mayfield Rd	15.72	13.31	0.85	14.08	12.12	0.86
Goreway Dr	Steeles Ave and Castlemore Rd	7.82	8.24	1.05	8.05	6.05	0.75
Hurontario St / Main St	Derry Rd and Mayfield Rd	23.53	17.80	0.76	14.22	15.15	1.07
Hwy 50	Steeles Ave and Mayfield Rd	13.43	14.94	1.11	11.73	10.86	0.93
Kennedy Rd	Derry Rd and Queen St	11.63	7.67	0.66	8.30	6.05	0.73
Mayfield Rd	Winston Churchill Blvd and Hwy 50	26.23	25.03	0.95	26.97	23.22	0.86
Mississauga Rd	Steeles Ave and Mayfield Rd	13.15	12.09	0.92	10.28	9.88	0.96
Queen St/Embleton Rd	Winston Churchill Blvd and Hwy 50	34.87	27.24	0.78	33.27	25.11	0.75
Steeles Ave	Winston Churchill Blvd and Hwy 50	34.62	23.94	0.69	29.58	20.90	0.71
The Gore Rd	Castlemore Rd and Hwy 50	7.53	6.37	0.85	7.05	5.29	0.75
Winston Churchill Blvd	Steeles Ave and Guelph St	9.65	9.78	1.01	8.55	8.15	0.95
Total		**266.57**	**227.54**	**0.85**	**245.13**	**196.36**	**0.80**

Summarized Results - 2011 Model Post Update	Peak Direction		Model / Survey	Off-Peak Direction	
	44%	7	within 10%	4	25%
	69%	11	within 20%	8	50%
	88%	14	within 30%	15	94%

Summarized Results - 2011 Original Model	Peak Direction		Model / Survey	Off-Peak Direction	
	31%	5	within 10%	1	6%
	50%	8	within 20%	5	31%
	88%	14	within 30%	9	56%

The updated 2011 model shows significant improvement over the original 2011 model, although the total congested travel times (227 mins vs. 266.5 mins) are 15% faster than observed, in the peak direction. *Of note, in the original 2011 model, the estimated congested travel times were 22% (207.8 mins vs. 266.57 mins) faster than observed values, in the peak direction.*

Issue: Lower travel times

As shown in Table 10 there is room for improving the model's congested travel time estimates. The improvements can be implemented by introducing node delays in the model or through an accurate representation of traffic operations in the corridor by adjusting link capacity. A table showing potential per lane capacity estimates stratified by road classification, surrounding land use, and traffic operations is presented in **Appendix D,** for discussion purposes. The appropriate methodology will be reviewed and implemented in Stage 2 of the model update.

Stage 2 Update

3.6.4 Transit Assignment

The City of Brampton's transit system is composed of two primary services. First, regular bus services; and second, the express Zum service along Main /Hurontario Street, and Queen Street. **Figure 8** shows the P.M. peak period ridership across all the transit services within the City.

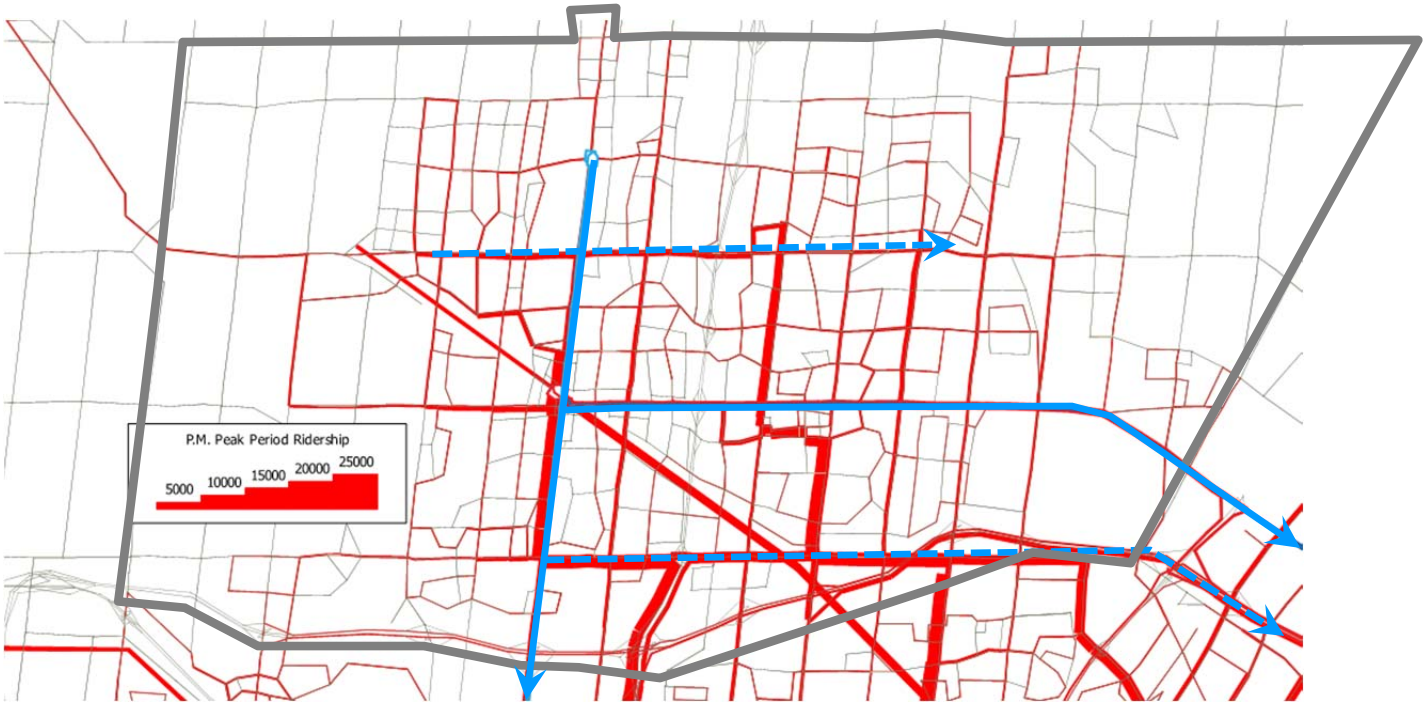


Figure 8: P.M. Peak Period Ridership in the City of Brampton - 2011 Updated Model

The key transit conduits in the City lie along existing and planned Zum corridors like Queen Street, Main/Hurontario Street, Steeles Avenue, and Bovaird Drive. Since the Steeles Avenue service started post 2011 it is highlighted as a future corridor (dashed line) along with the service on Bovaird Drive that is planned for early 2014.

Table 12 compares the modeled to observed 2011 boardings in the P.M. peak period for 43 different transit routes in the City, including the Queen Street and Main/Hurontario Street Zum. The graph at the bottom of the table displays the difference between the modeled and observed boardings for each of the 43 transit lines. The blue bar represents higher model boardings, whereas the red bar represents lower model boardings.

The BSGM estimates 975 more peak period boardings along the Edenbrook line when compared to observed counts. This over estimation is primarily due to the transit trip distribution patterns witnessed in Table 5, where transit trip attractions to super zone # 2 and # 3 were significantly over reported.

Assessing the BSGM's transit performance coupled with the transit trip distribution patterns it becomes apparent that either the 2011 TTS data or the 2011 boarding data is inaccurate. This is because although the BSGM is producing more P.M. peak

period transit trips, it is 8% lower on the total boardings, especially in some key corridors such as Steeles Avenue and Queen Street. Given the rigor instituted by the City in collecting transit data it is reasonable to assume that the 2011 TTS, which is currently in a pre-release format, is under predicting P.M. peak period transit travel to, from, and within the City. *The original 2011 P.M. peak period model under reported boardings by close to 15%.*

Table 12: P.M. Peak Period Modeled vs. Observed Boardings - 2011

Number	Route	2011 Observed Boardings	Model Boardings	Model / Observed	GEH
1	Queen	1,843	631	0.34	34
2	Main	771	809	1.05	1
3	McLaughlin	814	480	0.59	13
4	Chinguacousy	1,426	1,186	0.83	7
5	Bovaird	1,847	2,135	1.16	6
7	Kennedy	1,985	2,174	1.10	4
8	Centre	596	127	0.21	25
9	Vodden	357	941	2.64	23
10	South Industrial	161	73	0.46	8
11	Steeles	3,168	2,079	0.66	21
12	Grenoble	309	514	1.66	10
13	Avondale	110	8	0.07	13
14	Torbram	1,206	2,246	1.86	25
15	Bramalea	1,220	983	0.81	7
16	Southgate	197	38	0.19	15
17	Howden	323	111	0.34	14
18	Dixie	1,562	1,679	1.07	3
19	Fernforest	402	160	0.40	14
20	East Industrial	147	25	0.17	13
21	Heart Lake	38	30	0.80	1
23	Sandalwood	984	545	0.55	16
24	Van Kirk	223	524	2.35	16
25	Edenbrook	95	981	10.33	38
29	Williams	594	454	0.76	6
30	Airport Road	1,089	1,026	0.94	2
31	McVean	49	136	2.77	9
32	Father Tobin	107	114	1.06	1
33	Peter Robertson	68	84	1.23	2
40	Central Industrial	88	50	0.56	5
50	Gore Road	411	295	0.72	6
51	Steeles West	419	439	1.05	1
52	McMurchy	712	32	0.04	35
53	Oaklea	271	189	0.70	5
54	James Potter	394	172	0.44	13
92	Bramalea GO	29	87	3.00	8
115	Airport EXPRESS	169	508	3.00	18
501	Zum Queen	3,660	2,998	0.82	11
502	Zum Main	2,108	2,638	1.25	11
Total		**29,952**	**27,701**	**0.92**	**13**

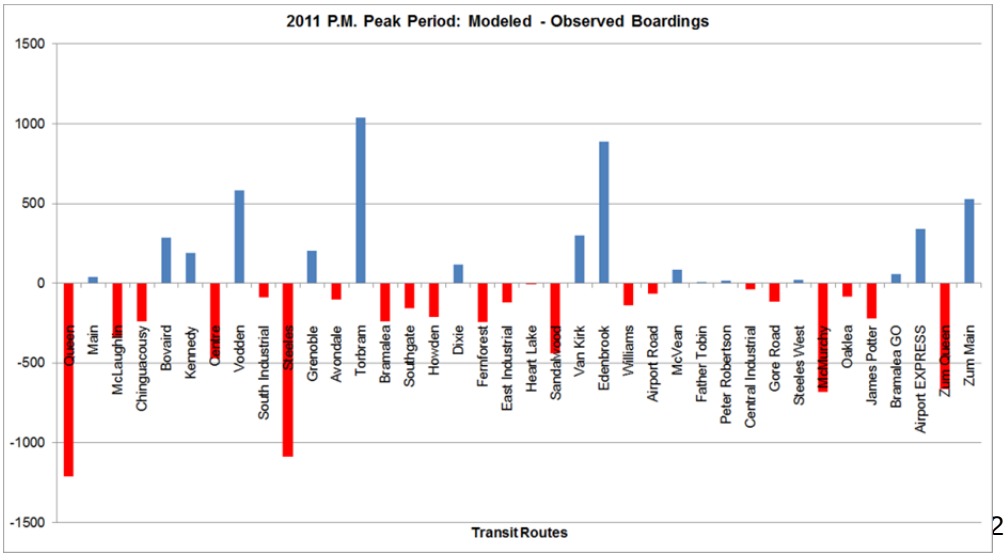


Figure 9 highlights nodes with significant boardings and alightings in the City. Nodes with the highest transit activity lie along Steeles Avenue, Main/Hurontario Street, and along Bovaird Drive west of McLaughlin Road, which are all existing or planned Zum corridors, thus corroborating the transit planning efforts being undertaken by the City.

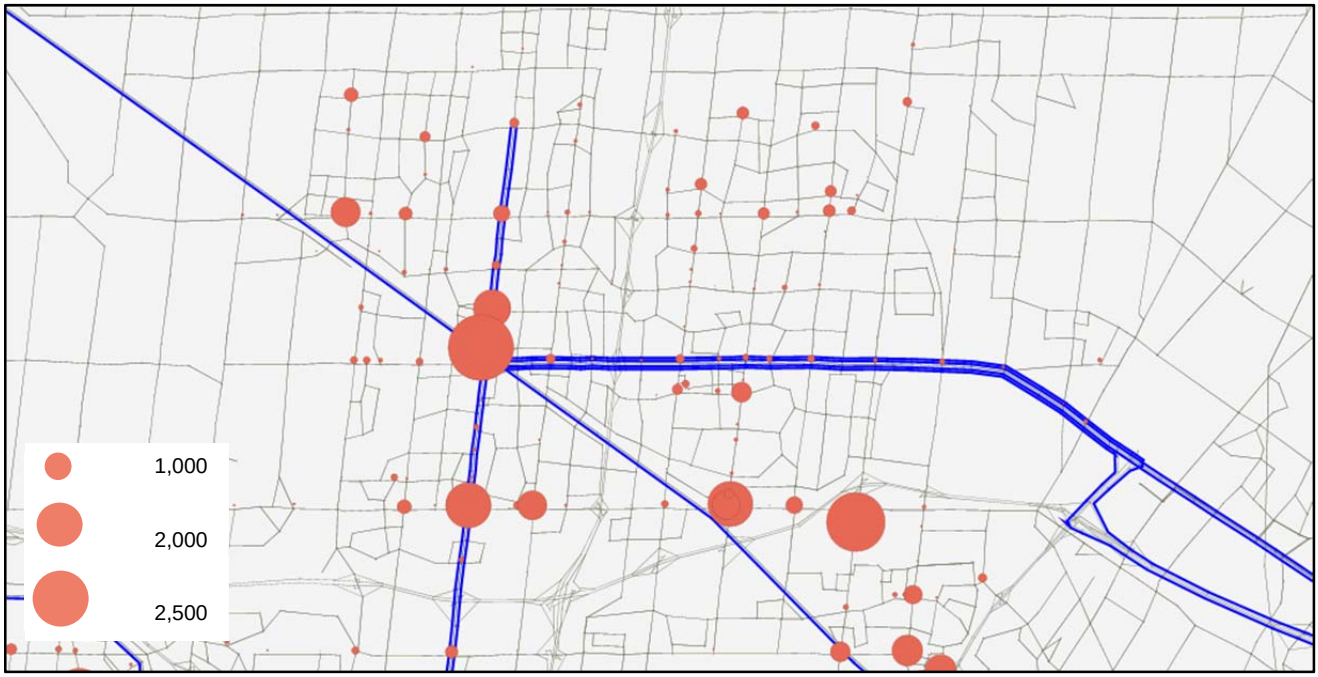


Figure 9: 2011 P.M. Peak Period Updated Model Boardings and Alightings

3.6.5 Zum Performance

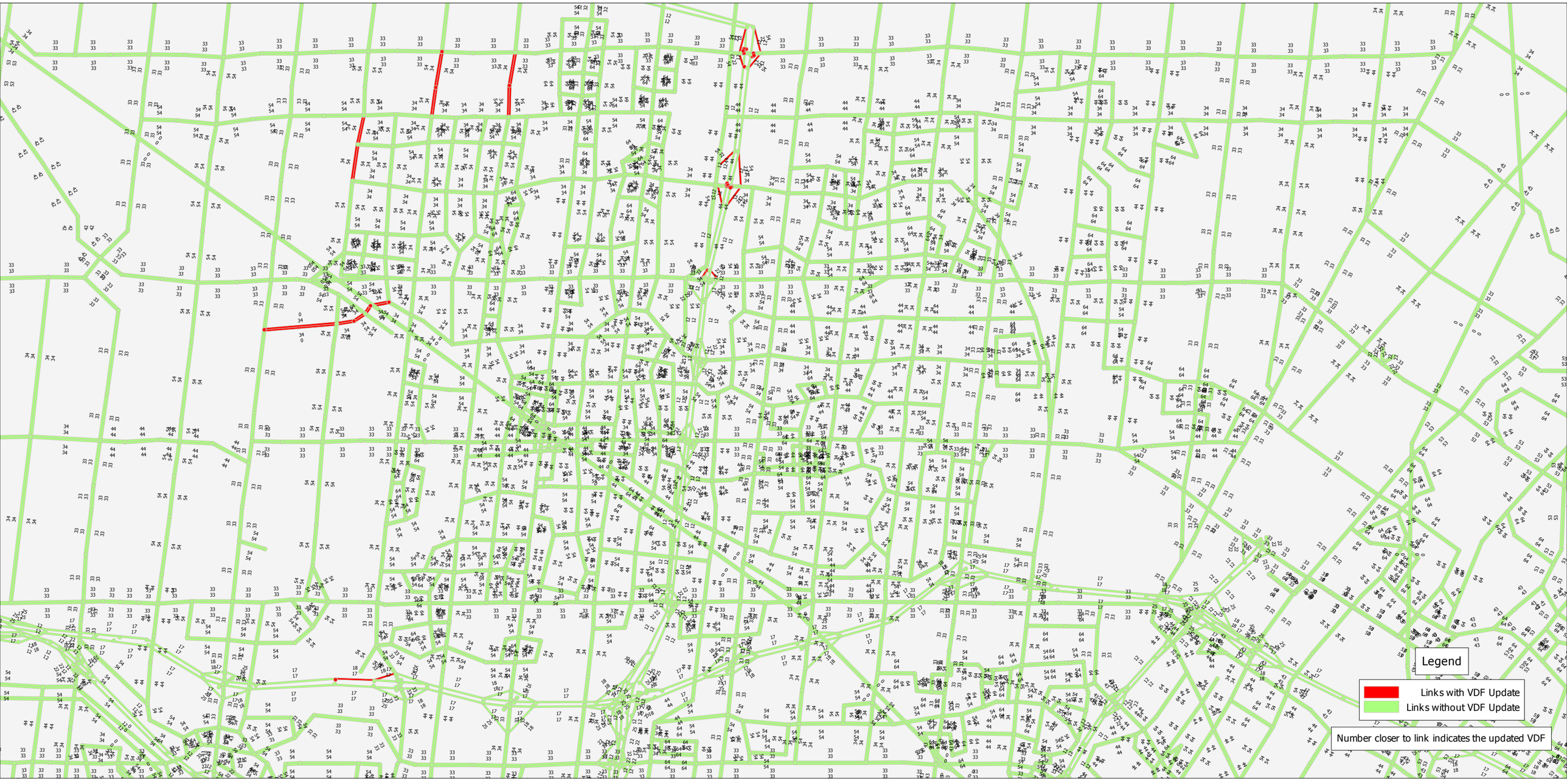
Results in **Table 12** indicated that the BSGM is estimating 18% fewer boardings along Queen Street Zum and close to 25% more boardings along Main/Hurontario Street.

The local transit trip distributions (Section 2.5) between the City of Brampton and the rest of the GTHA (Table 4), as well as within the City of Brampton (Table 5) do not highlight any significant underreporting of transit trips that could explain the fewer boardings being witnessed on Queen Street Zum. However, there are a number of other transit routes operating in the Queen Street corridor that could be potentially competing with the Zum system. Given that in the future all non-express routes will be removed from the Zum corridors this “cannibalizing” of trips is not expected to be an issue.

The Main/Hurontario Street Zum is over reporting boardings by a little over 500 in the P.M. peak period, which can be primarily attributed to the higher trip attractions from the City of Mississauga. This is not a very critical issue and is expected to resolve itself as further refinements are carried out in Stage 2 of the model update.

Appendix A. Changes to Auto Network

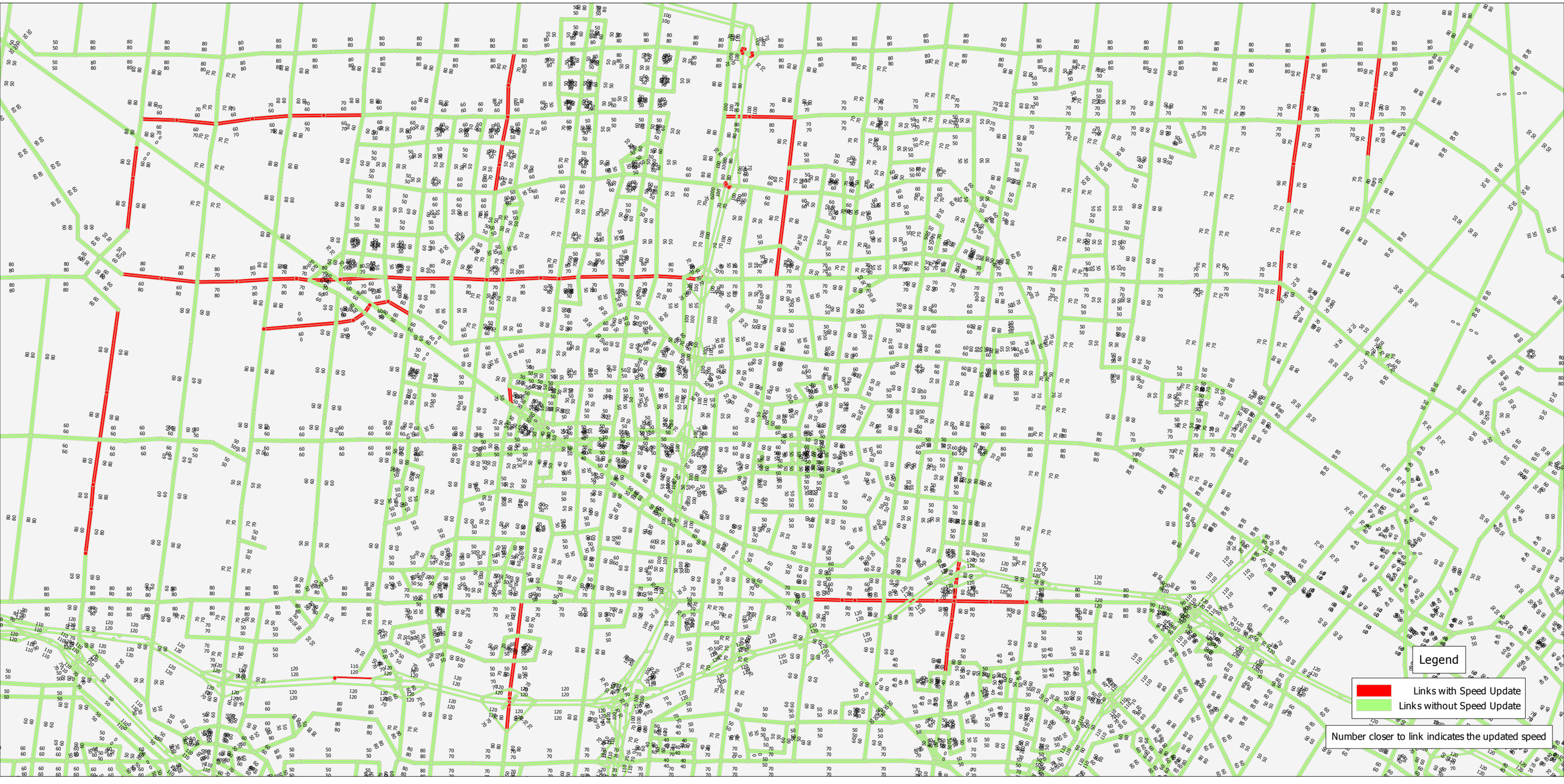
VDF Update



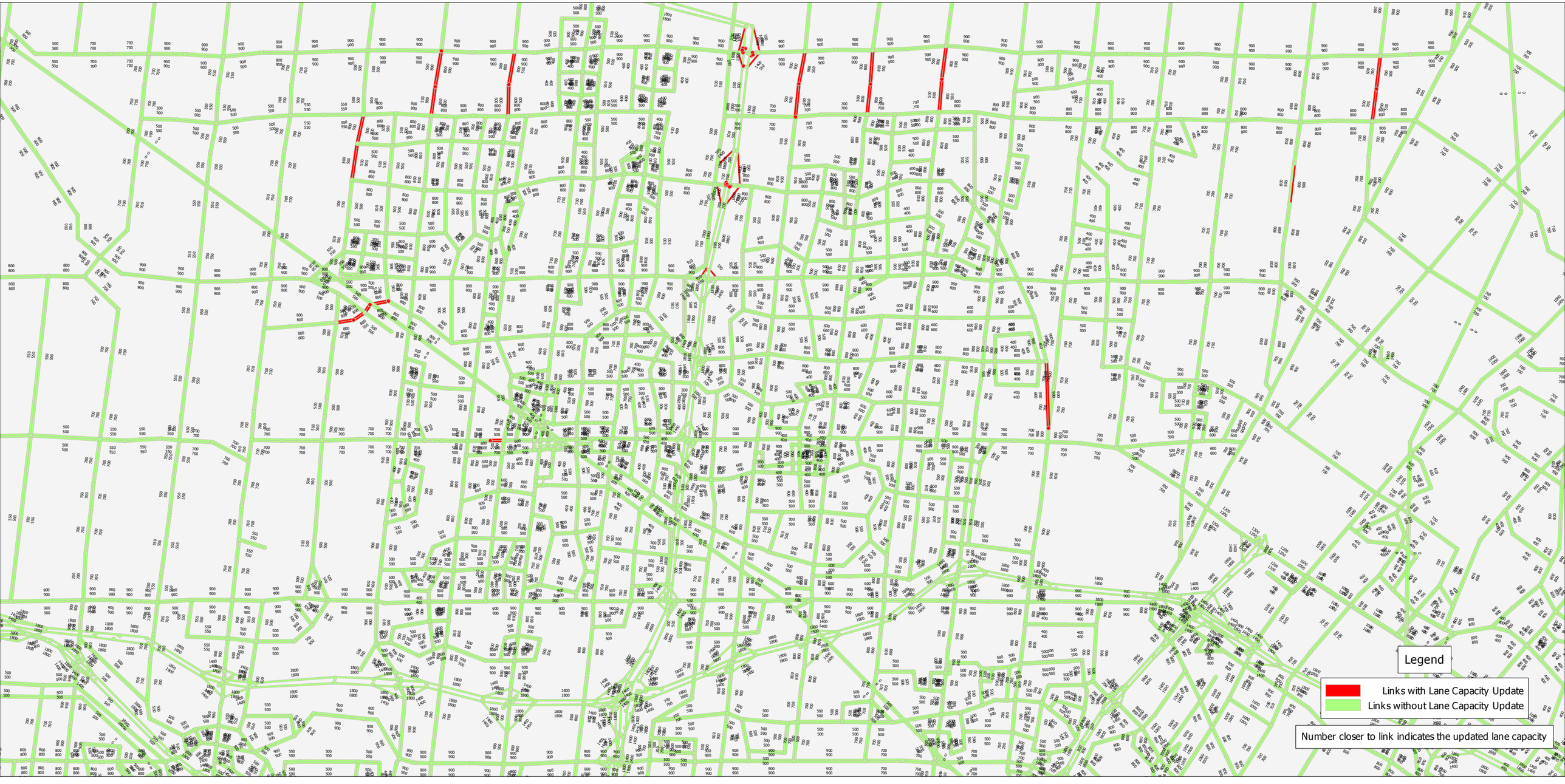
VDF Changes:

fd12 = ul2 * 80 (20% reduction in freeflow speeds)
fd33 = ul2 * 90 (10% reduction in freeflow speeds)
fd34 = ul2 * 90 (10% reduction in freeflow speeds)

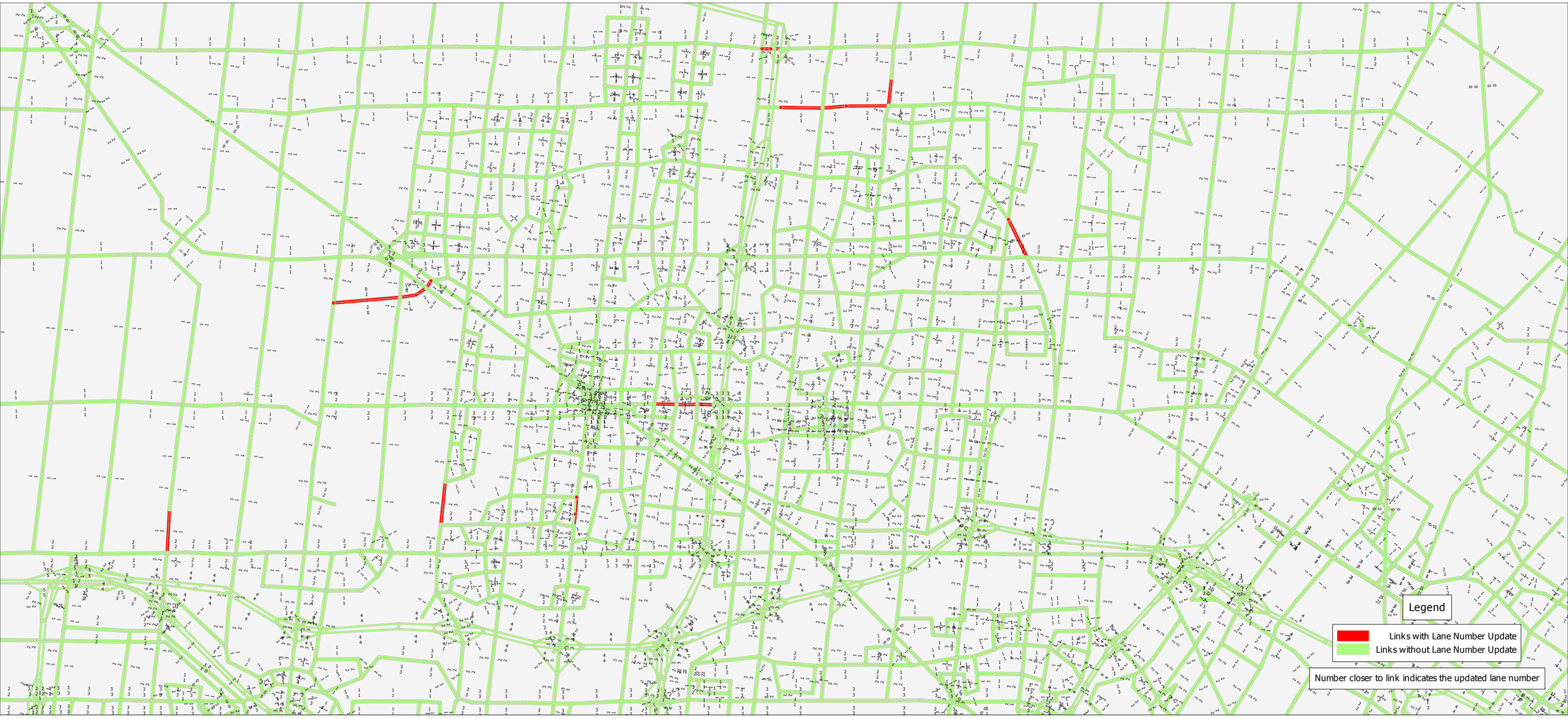
Speed Update



Lane Capacity Update



Number of Lanes Update



Appendix B. Changes to Transit Network

New Transit Lines

Route Number	Route Name
501	Zum Queen
501A	
502	Zum Main
21	Heart Lake
29	Williams
31	McVean
32	Father Tobin
33	Peter Robertson
51	Steeles West
53	Oaklea
54	James Potter
115	Airport EXPRESS

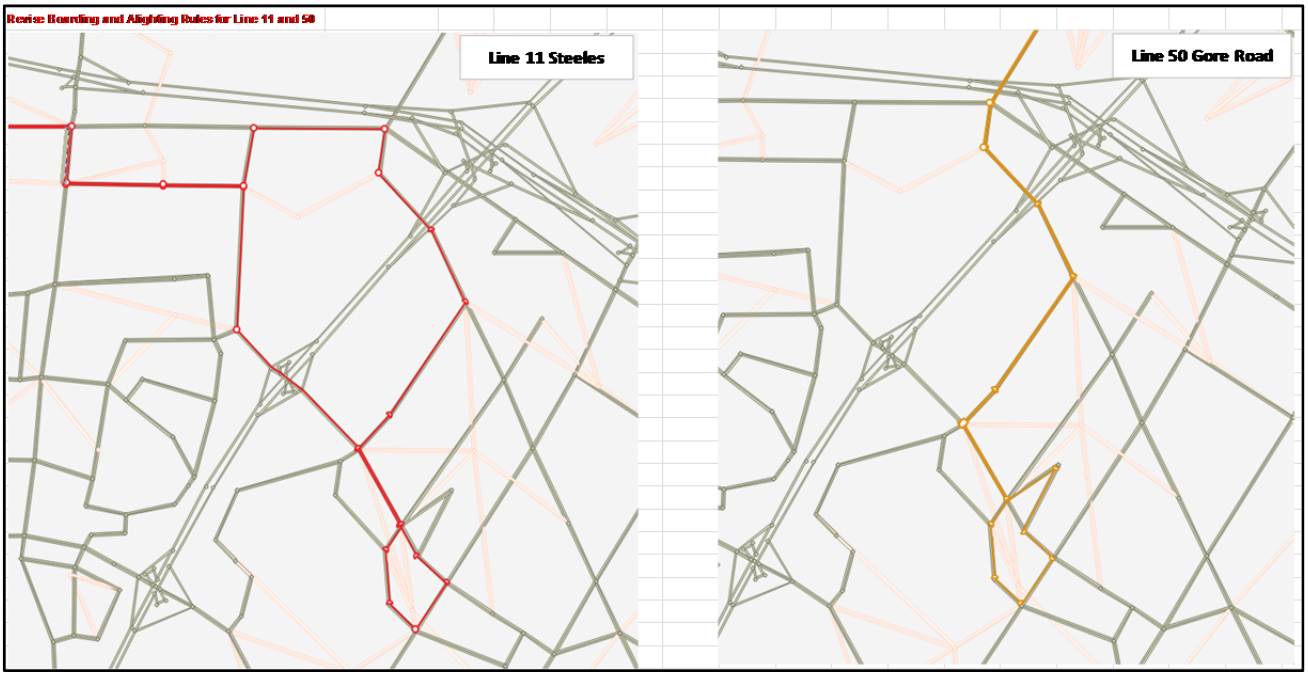
Deleted Transit Lines

Route Number	Route Name
6	Mackay
22	Springdale
26	Fletchers Meadow
77	Finch Subway
91	GO A

Transit Lines with Updated Headways based on 2011 Frequency Guide

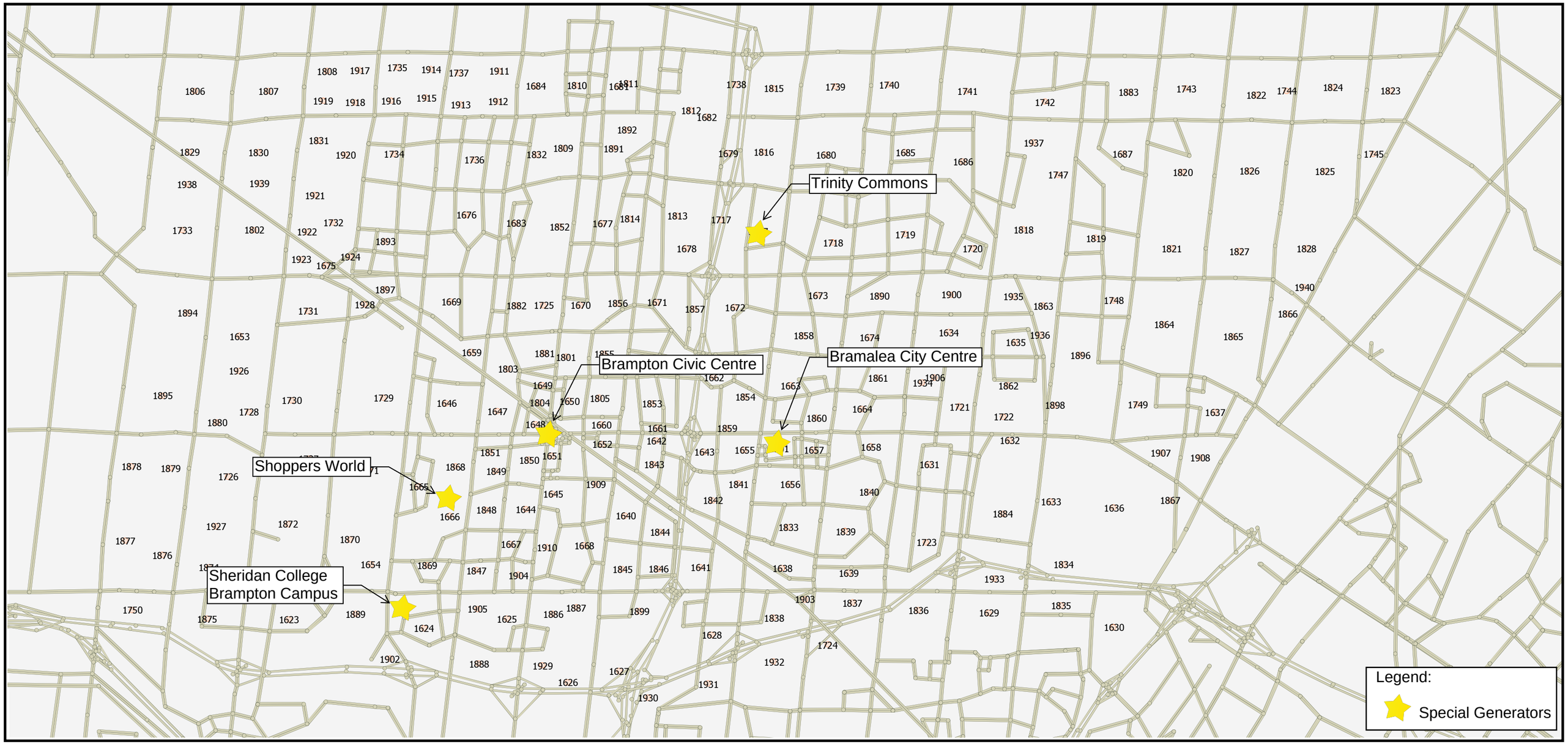
Route Number	Route Name	2011 Frequency Guide	Original Headways in Model
2	Main	20	10
3	McLaughlin	15	20
4	Chinguacousy	10	15
5	Bovaird	10	20
14	Torbram	10	20
15	Bramalea	10	30
16	Southgate	30	20
19	Fernforest	20	30
23	Sandalwood	15	30
50	Gore Road	20	40
52	McMurchy	20	15


Added "Walk Only" Connectors for Transit Access


Revise Boarding and Alighting Rules for Line 11 and 50
Line 11 Steeles
Line 50 Gore Road

Appendix C. Special Generators

Special Generators



Appendix D. Road Capacity Classification

Brampton Transportation Master Plan - Road Classification System (FOR DISCUSSION PURPOSES)						No TWLTL	WITH TWLTL	
Area	**Operational Class**	**Adjacent Lane Use**	**Traffic Operational Conditions**	**Speed**	**Lanes / Direction**	**Capacity/Lane**	**TWCLR** (Y or N)	**Capacity / Lane**
N/A	**Freeway**	N/A		90-110	N/A	1800	N/A	1800
N/A	**Urban Expressway**	N/A		90-110	N/A	1800	N/A	1800
N/A	**Freeway Ramp**	N/A		70	N/A	1400	N/A	1400
N/A	**Toll Highway**	N/A		90-110	N/A	1800	N/A	1800
N/A	**Toll Highway Ramp**	N/A		70	N/A	1400	N/A	1400
N/A	**Freeway/Expressway HOV**	N/A		90-110	N/A	1800	N/A	1800
N/A	**Freeway/Expressway HOV Ramp**	N/A		70	N/A	1400	N/A	1400
N/A	**Freeway/Expressway Truck Only**	N/A						
Rural	**Undivided Highway/Arterial**	Roads through mostly vacant lands or farmland		80	1	1000	N/A	1000
					2	1000	N/A	1000
Urban	**Principle/Major Arterial**	Low to medium density residential/commercial development with some access	Long signal spacing and good signal coordination/regression	60-70	1	800	Y	900
				60-70	2	825	Y	875
				60-70	3	850	N/A	850
	Major Urban Arterial	Low to medium density residential/commercial development with direct access	Close signal spacing, occassional illegal parking causing interference, some transit service	60	1	700	Y	800
				60	2	725	Y	775
				60	3	750	N/A	750
	Collector Road	Low to medium density residential/commercial development with direct access	Closer signal spacing, lower level of signal coordination and greentime allocation, some transit service	50-60	1	600	Y	700
				50-60	2	625	Y	675
				50-60	3	650	N/A	650
	Downtown/City Centre Collectors	Roads in high density office/commerical (CBD) with high pedestrian activity, parking, etc.	Presence of heavy transit and cyclists	50	1	500	Y	600
				50	2	525	Y	575
				50	3	550	N/A	550
	Downtown/City Centre Local Roads	Roads providing access to local streets	All-way stops and other traffic calming measures	40-50	1	400		
				40-50	2	450		
	Local Streets	Centroid connectors		40	1			9999 *

*Note: A capacity per lane is used for modeling purposes.